Accepted Manuscript

Title: Towards high-resolution shell midden archaeology: experimental and ethno-archaeology in Tierra del Fuego (Argentina)

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PII: S1040-6182(11)00230-8

DOI: 10.1016/j.quaint.2011.04.017

Reference: JQI 2756

To appear in: *Quaternary International*

Received Date: 21 February 2011

Revised Date: 7 April 2011

Accepted Date: 9 April 2011

Please cite this article as: Godino, I.B., Alvarez, M., Balbo, A., Zurro, Débora, Madella, M., Villagran, X., French, C. Towards high-resolution shell midden archaeology: experimental and ethno-archaeology in Tierra del Fuego (Argentina), Quaternary International (2011), doi: 10.1016/j.quaint.2011.04.017

Towards high-resolution shell midden archaeology: experimental and ethno-archaeology in Tierra del Fuego (Argentina)

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Abstract

This paper discusses the ongoing ethnoarchaeological research carried out in Yamana shell middens of Tierra del Fuego. Ethnoarchaeology is used in this research as a tool to improve the archaeological methodology by testing it against anthropological, ethnographical and ethnological sources for achieving more accurate reconstructions of past societies. The ethnographical/ethnological information also is coupled with an experimental approach devised to understand physical and social processes, such as site formation processes and resource use and management. Specifically, this experimental approach was applied to the archaeological sites Túnel VII and Lanashuaia I (Tierra del Fuego, Argentina).

Keywords: *Ethnoarchaeology, shell middens, Yamana, Tierra del Fuego.*

1. Introduction

One of the long-lasting aims of archaeological inquiry is to achieve high-resolution explanations of human past that could give account for long-term social processes as well as for the practices of everyday life. From this perspective, ethnoarchaeology gives an opportunity for a better understanding of past societies. Ethnoarchaeology is intended as an experimental and conceptual framework for testing archaeological methods and techniques against external information available for a specific human society (i.e. ethnographical and experimental information) within a given environmental setting (see Estévez and Vila, 1996a, 2006b, 2007; Estévez, 2009; Briz, 2010). The ultimate goal in this approach is the improvement in the historical explanation through the development of the archaeological method (Gould, 1980; Davidson, 1980; Agorsah, 1990: 191; Audouze, 1992; Béyries, 1997; Béyries and Pétrequin, 2001; David and Kramer, 2001; Kuznar, 2001; Adams 2004; Schmidt, 2006; Kuznar and Jeske, 2007; Roux, 2007) by using experimental analogy (Estévez and Vila, 2000; Briz, 2010) as an inference tool (Gándara, 1990; Kuznar and Jeske, 2007; Briz and Vietri, 2011.).

The first evidence for the peopling of the southernmost part of South America (Tierra del Fuego) comes from Tres Arroyos, an archaeological site located in the northern part of the Tierra del Fuego island, where radiocarbon dates show an occupation of terrestrial hunter-gatherer at around 10,000-11,000 BP (Massone, 2004). The archaeological research undertaken in this region has shown that coastal societies with a high level of management, the exploitation of marine resources and nautical technology first established on the coasts and channels of the Magellan-Fuegian archipelago at around 7,000 BP (Orquera et al., this issue). In the present case study, the society under study is the Yamana people, which have been described by ethnographers as the last hunter-fisher-gatherer (h-f-g) groups that inhabited the southernmost tip of South American continent (Gusinde, 1937). The paper will outline the ethnoarchaeology methodological approach that has been carried out with the aim of increasing the level of resolution of the archaeological interpretation. Specifically, the focus is on three major analytical lines: micromorphology, phytolith analysis and the context of use of lithic artifacts (Álvarez, 2003). These lines of investigation are taken as examples of the high-resolution capability for ethnoarchaeological research in shell middens.

2. Yamana society of Tierra del Fuego: an ethnographical and archaeological case study

2.1. Ethnology and ethnoarchaeology of Yamana

Yamana society can be described as a hunter-fisher-gatherer society with a high level of marine resources management. XIX century ethnographers considered the use of canoes as the major traits of this society, to exploit and manage coastal resources and the extensive use of fire for maintaining body temperature (Gusinde, 1937). The use of nautical technology established a pattern of subsistence at regional scale based on the consumption of marine mammals (South American fur seal, *Arctocephalus australis* Zimmerman, and sea lion, *Otaria flavescens* Shaw), shellfish, fishes and whales. At the same time Yamana people also hunted terrestrial mammals such as guanaco (*Lama guanicoe* Müller), coastal birds such as kelp gull (*Larus dominicanus* Lichtenstein) and albatross (*Diomedea exulans* L.) and collected plants and mineral resources from the inland areas (Álvarez et al., 2010; for an in-depth discussion on hunter-fisher-gatherer societies of Beagle Channel see Orquera et al., this issue).

The importance of the Yamana as a case study for the development of the ethnoarchaeological approach rests on three aspects that allow for a more profound control of the archaeological record:

1) There is a rich ethnographic documentation coupled with a relative social isolation caused by the extreme geographical isolation (the southernmost tip of South America). Indeed, contacts with agro-pastoral societies are not documented until the first, sporadic encounters with the European explorers during the XVI and XVII century (Estévez et al., 2002). The real colonization of this territory was carried out only during the XIX century (Gusinde, 1937; Orquera and Piana, 1999a), with the result of the destruction of the Yamana society~~.~~ As a consequence, all pre-contact changes observed in the Fuegian h-f-g societies can be considered the product of internal processes and not acquisitions through contact with agricultural societies (Estévez et al., 2002). The high-quality ethnographic record on the Yamana society includes a great variety of sources such as letters, notebooks and ship logs of sailors and travellers (e.g. Forster, 1777; Fitz-Roy, 1839; Hyades and Deniker, 1891), the ethnographical work of M. Gusinde (1937), the video documentary of A. M. De Agostini from the beginnings of the XX century (Maturana, 2006) and a large number of diverse ethnographical collections scattered in museums around the world.

2) Climatic and environmental change in Tierra del Fuego has been minor over the last few centuries and the changes related, for example, to the Little Ice Age, although noticeable (Obelic et al., 1998), are less expressed than in temperate latitudes (Mauquoy et al., 2004; Orquera and Piana, 2009: 63). It is possible therefore to assume that climate change has had little impact on the Yamana for the period (the last two centuries) that is the subject of ethnographical and ethnoarchaeological research. Present-day climate in Tierra del Fuego is characterized by oceanic conditions (Tuhkanen, 1992) despite its proximity to Antarctica. Seasonal variations between summer and winter are not strong and recurrent rain, low temperatures, constant winds as well as frequent storms characterize meteorological conditions all year round (Heusser, 1989; Orquera and Piana, 2009). Snow is more common during the winter, when average temperatures are slightly lower than in summer (year average temperature is 5.3ºC; Orquera and Piana, 1999b).

3) The most recurrent archaeological sites of the Beagle Channel region are shell middens formed by multiples episodes of shell deposition mixed with the remains from diverse production and consumption activities. This situation offers a most favourable framework to assess the ethnoarchaeological perspective because it provides a fine-scaled archaeological record with fast sediment accumulation rates (Stein, 1992; Orquera, 1999; Vale and Gargett, 2002; Stein et al., 2003; Verdún et al., 2010). Moreover, the identification of stratigraphic units on the basis of both shellfish composition and topographical distribution allows disentangling the social and environmental processes that produced these structures (Orquera and Piana, 1992; Estevez and Vila, 2006a). Thus, it is possible to achieve an accurate picture of the activities and their spatial organization.

2.2 Archaeology of Fuegian shell middens

Although the first explanation for the origin, function and purpose of the Fuegian shell middens was proposed by Darwin as early as 1839 (Darwin, 1839), it was only in the 1920s-1930s that Tierra del Fuego became the focus of archaeological research (see Bird, 1938, 1946). The presence of pristine hunter-gatherer societies (Yamana, Selk'nam, Manekenk, Kawesqar) attracted the first ethnographers (Vega and Grendi, 2002) that also had an interest in the temporal (archaeological) perspective of these groups. This eventually led to the development of the ethnoarchaeological approach (e.g. Furlong, 1917; Lothrop, 1928). Later, special attention was given to settlement formation processes (Vignati, 1927, Sánchez Albornoz, 1958; Morón, 1993; Menghin, 1952, 1956) but it was only in the 1970s that the hunter-fisher-gatherer societies of the Beagle Channel became the focus of a major archaeological research project (Orquera et al., 1978; Orquera and Piana, 1996b, 1999b, 2009). The aims of this project were, among others: (1) to develop an *ad hoc* excavation method specific for the Fuegian shell middens (Orquera and Piana, 1992, 1999a) and (2) to acquire a representative sample of the main occupation sequence of the region (Orquera and Piana, 2009).

During the 1980s a new ethnoarchaeological project was started in the area, with an interest in high-resolution shell middens deposits that would allow recognizing the dynamics of site formation and provide the possibility of distinguishing singular occupation events (Estévez, 2009; Vila and Estévez, 2001; Vila et al., 2007, Piana et al., 1992; Estévez and Vila, 1996b; Vila et al., 2009). This approach, while offering a great control of the archaeological stratigraphy directly in the field, also provides the ideal settings for the use and development of "high resolution" techniques, such as micromorphology, bioarchaeology and residue analysis. The research effort concentrated on three areas:

- The development of new lines of research in the region, such as anthracology (Piqué, 1997), phytolith analysis (Zurro et al. 2009), archaeozoology (Estévez et al., 2001; Juan-Muns, 1992; Mameli and Estévez, 2005), micromorphology (Balbo et al. 2010) and the recognition of spatial patterns (Wünsch et al., 1996; Vila et al., 2009).
- The improvement of recovery techniques such as excavation methods and sampling strategies for ichthyological (Juan-Muns, 1992; Estévez et al*.,* 2001) and malacological remains (Verdún, 2006), and phytoliths (Zurro et al., 2009; Zurro, 2010).
- The development of new approaches within established methods such as the study of form-function dynamics in lithics (see Briz, 2004; Briz et al., 2005). Technical innovation is also one of the main axes of investigation in the ethnoarchaeological approach.

Within this framework, current research is being carried out on remains from the sites Túnel VII and Lanashuaia I, both located on the northeaster side of the Beagle Channel (Fig. 2). Túnel VII is a shell midden situated on the northern coast of the Beagle Channel (54º 49’ 15’’S - 68º 09’ 20’’W) in a small cove, part of Estancia Túnel, about 10 kilometres east of Ushuaia. Fieldwork at this site was carried out within the framework of an international collaboration between Argentinean and Spanish teams (see Vila, 2004). The site is formed by a series of historical Yamana re-occupation episodes with a hut repetitively built on the same spot (Piana and Orquera, 1996; Estévez and Vila, 1996b, 2006a). Lanashuaia I (54° 52,75’ S - 67°16, 49’ W) is the first excavated part of a set of shell middens situated on the isthmus between Bahía Interior de Cambaceres (Inner Bay of Cambaceres) and Bahía Exterior de Cambaceres (Outer Bay of Cambaceres, which opens directly on the channel). Like Túnel VII (Orquera and Piana, 1996a), the site is a ring-shaped shell midden from the historical period (Piana et al., 2000), which was excavated in 1995, 1996 (Piana et al., 2000) and 2005 (Álvarez et al., 2009; Briz et al., 2009). As for most of the shell middens in the region, the ring structure of these sites was clearly seen even before excavation. The central depression was the inside of the hut while the ring structure surrounding it was formed by the deposition of the earth dug up from the centre and of the discarded shells and other rests deposited all along the hut’s periphery (Estévez and Vila, 2006a).

In the next pages, some methodological research undertaken in Tunel VII and Lanashuaia I will be presented. The archaeological sites were excavated under different research programs with specific objectives. Tunel VII served as a heuristic exploration tool in order to improve sampling methods and to open new avenues of research. Lanashuaia I addressed new methodological perspectives to shell middens archaeology based on experience at Tunel VII. Consequently, for each case study different lines of research are discussed, with the aim of assessing their potential in h-f-g contexts.

3. Methodological examples: recognizing stratigraphic relations and spatial patterns

Historical and ethnographical sources of Yamana society indicate a variable occupation of the sites, ranging from several days to some weeks (Orquera and Piana, 1999a). However, in some occasions, the huts were used seasonally over the span of a few years. This use was more or less intense depending on climatic conditions and food availability (e.g. the presence of a stranded whale, or in case of a *Iacasi*: Yamana word for a great amount of beach-stranded fish). Therefore, the occupation pattern of Yamana settlement was characterised by a double cycle of use and abandonment: the short-term seasonality cycle and the long-term cycle of movements in the landscape. The aims of the archaeologists have always been to identify these different occupation episodes (including the repetitive use of fireplaces) as well as to unravel the spatial organization of the daily activities in order to understand social dynamics in h-f-g societies. The use of micromorphology and phytoliths analysis is decisive in the clarification of such issues.

3.1. Micromorphology

Micromorphological analyses of archaeological sediments were done to refine the identification of stratigraphical and spatial patterns inside the shell midden, and to understand its formation processes and possible taphonomical alteration. Two sets of micromorphological samples from experimental and ethno-archaeological contexts were collected in the 1980s and the 1990s (Estévez and Vila, 2007; Vila, 2004). The experimental and modern analogue samples were taken from a number of control features to build a reference collection of known anthropic and natural features including fireplaces and other combustion features, trampling areas and forest litter (Taulé, 1995; Vila et al., 2007; Villagrán et al., in press). Ethnoarchaeological micromorphological samples consist of a 50 cm column (Column 11, Figure 3) from Túnel VII (Estévez and Vila, 1996b; Orquera and Piana, 1996a). Column 11 was extracted during excavation of the site in 1992 from a portion of the shell midden originally described as the hut entrance and associated floor (Balbo et al*.,* 2010). Seven thin sections, covering the complete sequence of the site, were obtained from the sediment column. The analysis was carried out under PPL, XPL and OIL following established guidelines (Bullock et al., 1985; Fitzpatrick, 1993; Kemp, 1985).

Micromorphological observations on samples from ethno-archaeological contexts were compared with observations made on thin sections from the modern analogues to better understanding the extent and intensity of shell midden frequentations, the function and reiterated use of fireplaces, and the masking effects of depositional and postdepositional processes on the final examined sample. In this sense, both Túnel VII and Lanashuaia I offered a unique opportunity to test the utilised archaeological methods employed with ethnographical and historical information, also thanks to the limited time elapsed between site abandonment and excavation. When working on recent deposits, it is possible to relay on extensive historical archives describing the social and cultural aspects of the native groups (e.g. Mallol et al., 2007; Shahack-Gross et al., 2003). Also, the lack of major climatic and environmental changes during the time period under investigation (see 2.1), allows identifying with a greater resolution features generated by depositional and post-depositional processes.

3.1.1. Enthnoarchaeological stratigraphy at Túnel VII

In the case of ethnoarchaeological samples, the micromorphological analysis of the monolith column taken from the Túnel VII shell midden (Figure 3 a and b), suggests:

(a) a model for hut construction in terms of its position within the landscape and draining technology;

(b) a model for the timing and intensity of frequentation and abandonment of the site over the relatively short overall frequentation (c. 150 years). Soil disturbance at the base of the hut reinforces observations made in the field suggesting that a circular depression was dug in an area of the beach situated just above the storm line when the hut was established. The shallow soil covered in grass was dug to reach the underlying gravel, possibly to favour drainage. The position of the settlement was chosen to be as close as possible to the sea but to avoid inundation under stormy conditions. Units rich in highly fragmented, often burned and randomly organised shell and bone fragments were differentiated from layers presenting edaphic features typical of incipient soil formation. The first type of units represent different phases of frequentation, which duration/intensity could be preliminarily defined based on layer thickness, randomness of distribution in the coarse fraction, and fragmentation of shell (and bone). In contrast, the second type of units would have formed during abandonment of the site, which duration is expressed in the degree of expression of the edaphic traits observed under the microscope. Micromorphological analyses of column 11 clearly show that the longest abandonment phase at the site coincided with the formation of an incipient soil about halfway down the profile with well-expressed edaphic features (Micromorphological unit 11 – Field unit B35, Figure 3 a and b).

Units below unit 11 seem to actually represent the entrance and floor of a seasonally occupied hut with periods of more or less intense use alternated to short periods of abandonment reducing the accumulation of anthropogenic material but not allowing the formation of a soil. This succession of occupation and abandonment phases of different length and intensity may represent distinct exploitation strategies. In contrast, units above unit 11 belong more likely to the edge/rim of a new slightly displaced hut, built after a longer time had elapsed since the previous occupation (Balbo et al., 2010). These units seem to represent the re-use of the area after an extended period of abandonment, also implying changing strategies of landscape occupation.

3.1.2. Experimental and modern analogue samples

The micromorphological analysis of experimental and modern analogue samples produced during the 1995 field season in the vicinity of the Lanashuaia site, provided three key outcomes relevant for interpretation of the archaeological record:

1) The possibility of systematically associate different degrees of calcination of shells (*Mytilus edulis* L. shells in the specific case study) with controlled combustion temperatures (Figure 3 d). The systematic recording of the degree of calcination in shells exposed to increasingly high temperatures for a controlled amount of time, ultimately allows differentiation of fire structures. This information combined with archaeological data (e.g. position of the fireplace within the wider context, presence of particular tools) and with palaeoenvironmental information (e.g. specific plant remains - phytoliths - and animal remains), allows the proposal of new interpretations relative to fireplace function and intensity of use.

2) The possibility to microscopically distinguish bones (whale bones in the specific case study) altered within an anthropogenic context (archaeological, ethnographical or experimental) from bones altered in a ‘natural’ context (bones altered in the two contexts appear similar at a first optical examination) (Figure 3 c). Whalebone fragments ‘naturally’ weathered as part of the beach deposit can be microscopically distinguished from bone fragments altered by exposure to high temperatures (e.g. fireplace) based on the identification of dissolution areas, and on the characterization of the organic and mineral fraction in the bone (Hedges, 2002; Jans et al., 2002; Lucas

and Pévôt, 1991; Tuross et al., 1989). The possibility to differentiate naturally altered bones from bones altered in an anthropogenic context is key in characterizing archaeological contexts in this cold environment, where whale is one important resource for the creation of social ties among local human groups (Briz et al*.,* 2009).

3) The identification of the intense bioturbation that characterizes the region, despite cold climatic conditions traditionally considered to inhibit biological activity. The thin sections from current soil profiles (taken near Lanashuaia) show that most of the material within these very thin soils is composed of humified organic matter or iron replaced plant tissue fragments. Some horizonation is evident in these deposits. However, the humified organic matter is all severely bioturbated as a result of intensive soil-fauna activity. This extremely high bioactivity is rather surprising for soils at this latitudes and it could interfere with the micro-stratigraphy of the archaeological sites, as has also been noted in thin sections from Túnel VII (Balbo et al., 2010). Based on these results, it is possible to assume that the effect of taphonomic processes (e.g. trampling, chemistry, humification) is virtually the same in sediments within and outside archaeological contexts. Post-depositional processes that might have been of greater importance in shell midden archaeological contexts than elsewhere include: higher bioturbation within the central depression than in the surrounding soils and sediments, more accentuated dissolution and re-precipitation of secondary carbonates and higher shell concentration and fragmentation associated with human activity.

3.2. Phytolith analysis

Ethnographic information about the Yamana points not only to an intensive use of plant material as fuel and of wood as a resource for the construction of the huts (as well as for making handles, canoes, etc.) but also to the use of other taxa for many different purposes. The native tussock grass (*Poa flabellata* (Lam.) Raspail) seems to have been used for the conditioning of the inside of the dwelling. It was apparently used to insulate hut from the ground humidity by arranging these plants as a kind of mattress (Gusinde, 1937). Mosses, on the other hand, would have been used for hygenic purposes as well as for filling in the dwelling walls in order to avoid draughts. Edible plants are not numerous in the area, but there are some edible berries (e.g. *Berberis buxifolia* Lam.*, Berberis ilicifolia* L.f.*, Empetrum rubrum* Vahl ex

Willd. *or Pernettya mucronata* (L.f.) Gaudich. ex A. Spreng. = *Gaultheria mucronata* (L.f) Hook et Arn.) and small tubers (e.g. dandelion - *Taraxacum gilliesii* Hook. et Arn. = *T. magellanicum* Comm. ex Sch. Bip.) that seem to have been eaten (Orquera and Piana, 1999a: 175-177).

On the contrary, archaeological research in the area has never been particularly focused on archaebotany, with few exceptions (see Piqué, 1999). Considering that in most cases these plant resources were not processed with fire, it was necessary to apply, apart from charred remains analysis, specific techniques that allow for the recovery of uncarbonised remains. Phytolith analysis was, in this sense, the best option.

In Túnel VII, phytolith analysis (Zurro and Madella, 2004) was used to explore the possibility of understanding the use of space within the Yamana settlement. From a methodological perspective, a specific interest was in understanding to which extent phytolith assemblages would give meaningful spatial within such a small area (Zurro et al., 2009). Indeed, the structure analyzed was the depression, with a diameter of about 3.5 m, related to the center of a temporal sequence of huts. This circle included a superimposed hearth sequence in its center.

Samples were collected from layer B355. This is a very organic occupation layer poor in shells (but it contains shell-powder within the soil matrix) (Orquera, 1996). It represents a floor episode and, based on the ethnographical record related to the indoor use of space, samples were collected so that they could reflect the expected activities undertaken. Two features were specifically targeted: areas close to the fireplace and the entrance of the hut (Zurro, 2010) (see Figure 4). Areas lacking any evident archaeological structure were also sampled.
Samples were treated in the laboratory following standard procedures (Madella et al., 1998) and analyzed under the optical microscope (Olympus BX-51) at x400 magnification (Zurro et al., 2009). The extracted phytoliths are "fresh-looking" and undamaged, pointing to good chemical and physical preservation. This in spite of the high presence of $CaCo3$ in the sediment as well as high ground humidity that would theoretically create a poor environment for phytolith preservation. It is possible, however, that the high presence of organic matter and low temperatures play down

the effect of high carbonates and water content, providing good conditions for the preservation of biogenic silica. The pH of the sediments was mostly around 7.

The amount of phytolith per gram of sediment is generally low (see Zurro et al., 2009) that, in the light of the previous discussion on preservation, seems to point to a general low phytolith input. In all samples, grass phytoliths are the dominant types, even though some woody taxa phytoliths are present. The spatial variability observed in the phytolith concentrations indicates, however, a highly heterogeneous input depending on the area of the floor. This variability does not seem to have a direct relationship with the features observed in the archaeological record, which are intuitively considered as possible areas of phytolith abundance (e.g. the areas around the fireplace or closer to the dwelling walls) (see Zurro et al., 2009 and Figure 4).

For instance, sample TVII 7, which is not part of the fireplace, is the richest sample within the analysed assemblage with a composition that is mainly based on grasses. This input might be related to an accumulation due to floor conditioning (e.g. mattresses), remains from working processes carried out on plant material inside the dwelling or part of the wall structure. On the contrary, two of the samples related to the hearth (TVII 1 and TVII 9) as well as sample TVII 2 show the highest frequency of woody taxa. This is consistent with the use of wood as fuel as observed by the ethnographers (see Zurro et al., 2009 for an in depth discussion of these results).

The hypothesis of the high spatial variability of phytolith assemblages in such archaeological contexts was supported by the results of these analyses. Phytoliths are highlighting some sort of spatial diversity, which would have been linked to activities carried out in the hut. There is in any case the need of more work on reference plant material as well as on activity markers for understanding more in depth the archaeological meaning of this phytolith variability.

3.3. Production-consumption dynamics in lithic technology: a multi-evidence approach

The critical review of historical written sources, published articles, and photographs of hunter-fisher-gatherer societies of Tierra del Fuego portrays a wide use of marine and forest resources. However, these resources, being mostly organic (e.g. plants, wood, hide, meat, tendons etc.), do not generally preserve well in the archaeological record. According to ethnographic sources, lithic technology played an insignificant role in resource procurement (Gusinde, 1937; Terradas et al., 1999). On the other hand, the archaeological record shows an important presence of lithic artifacts. As in most hunter-gatherer archaeological sites, more than half of the material found is lithic, so in this case archaeological data seems to provide a completely different view from ethnography, showing how necessary is to approach the acquisition of information from a critical standpoint balancing both ethnographic and archaeological information.

Stone tools offer the opportunity to test the spatio-temporal construct of the archaeological site as well as the processes of production and consumption because the tools have been involved, first during their production and then as working instruments, in a vast number of labour processes carried out by the h-f-g groups (Álvarez, 2003; Briz, 2004). To fully exploit this opportunity, however, there is the need of improving the study approach using a multi-evidence methodological framework that combines use-wear analysis, form-function relationship and residue analyses, starting in this case with the study of phytoliths as residues (Álvarez et al., 2009).

Use-wear analysis can help identifying the worked material as well as the kinematics involved, by observing the micro-traces present on artifacts edges with the aid of optical and electronic microscopes. This approach has been already applied to some Yamana sites such as Lanashuaia I, Lanashuaia II, Túnel VII, Túnel I and Imiwaia I (Clemente, 1997; Clemente and Terradas, 1993; Clemente et al., 1996; Mansur and Vila, 1993; Terradas et al., 1999; Álvarez, 2003; Álvarez and Briz, 2006; Briz et al., 2005). The form-function relationship of a lithic artifact is, on the other hand, addressed through a new perspective that attempts to deconstruct the way followed by the classic typological studies and focusing primarily on the labour processes in which the stone tools were involved and only subsequently exploring the elements of design associated with a particular task (Briz, 2004, 2007, 2010). Phytolith analysis from residues from the used artifact edges is being explored as a way to corroborate the information from the use-wear analysis (Álvarez et al. 2009).

With this approach in mind, a study was undertaken to understand the production-consumption processes at Lanashuaia I (Álvarez et al., 2009). Artefacts were selected according to the spatial location (to obtain representative samples from both inside and outside the dwelling unit) and their association (as probably relating to the same work processes). Sedimentary control samples were collected from the deposits in contact with each piece together with further controls representing the general depositional layer in which they were found. The first group of 34 artifact samples comes from different contexts including one shell layer (C200) and three from non-shell, fine-grained deposits with a high content of organic matter (B2, base of B800 and B900). The use-wear analysis followed the model proposed for crystalline coarse grain rocks (Mansur, 1999; Álvarez, 2003) because of the type of raw material used on the north coast of the Beagle Channel (e.g. rhyolites, fine-grained tuff and schists).

The results obtained from this approach suggested in the first instance an important change in the economics of raw material exploited by Yamana society in comparison with other settlements. Most of lithic artifacts of Lanashuaia I site were made of schists from the Yaghan Formation (Kranck, 1932). Conversely, the available data from the rest of archaeological sites show a clear predominant exploitation of local metamorphic ryolithes and fine-grained tuffs for making tools, since they have a better quality for knapping activities (Terradas 1996; Álvarez 2003). In general, the slate account for 5% of the lithic resources exploited although it constitutes the more abundant rocks on secondary deposits of fluvio-glacial origin along the Beagle Channel coast. One of the hypotheses that can be suggested for this shift on the raw material economy is the need of expedient tools (made on the spot) to take advantage of bulk resources, for example a beached whale (Briz, et al., 2009). Ongoing studies can help to resolve this question.

The artifact sample recovered in 2005 fieldwork exhibit a low percentage of use wear traces compared to others assemblages of the region. Three major reasons can explain these outcomes. First, the incidence of physical and chemical process (such as patinas and soil sheens) might have partially provoked polish destruction. Second, the slow rate of use-wear formation on schists could have led to a low frequency of discernible traces. Third, and most important, a great part of the assemblage was discarded without being used. Use-wear and morpho-technical analysis revealed that a great number of lithic artifacts formed part of a workshop (a flint knapping area) situated at the perimeter of the midden layers. Indeed, no traces of use were observed on 83.3% of the flakes.

In spite of the low proportion of used tools, it is interesting to note that the production-consumption activities included the working on different types of materials, such as (in order of importance) bone (see Figure 5), hard materials (bone, wood or mineral), hide and soft materials (meat, hide or plants). Cutting activities are predominant on hard materials, especially in the case of bone, whereas scraping activities are more common in the case of working of hide and soft materials.

A further interesting point that emerged from the lithic study is the disagreement of the results from the use-wear and phytolith analyses. No clear traces related to the work of plant tissues (either hard or soft) were identified but phytoliths, although in low concentrations, were recovered from the working edges. These phytoliths have a high morphological and frequency variability. The presence of these microremains might be as contaminant from the sediments or as effective witnesses to a secondary use of the utensils for working plant material that did had not leave evident traces on the surfaces (see Figure 6).

Finally, the data obtained from use-wear, morphotechnical and spatial analysis suggest certain spatial organization of production-consumption practices: the first stages of the reduction sequence (e.g. the production of blanks) and hide working were carried out just outside the dwelling unit while bone working as well as hard and soft materials processing were carried out inside (Álvarez et al., 2009).

5. Conclusions

Research carried out in Tierra del Fuego was used to discuss the validity of the ethnoarchaeological approach to test new developments in archaeology. The three strands of evidence examined include micromorphology, phytolith analysis and functional lithic analysis. These have been applied to two sites of the Beagle Channel: Túnel VII and Lanashuaia I. This approach acquired high-resolution dataset supported by ethnohistorical information, which was an essential condition for a better characterization of the different occupation events of the studied dwelling unit.

Micromorphological analysis in ethnographical and experimental sub-antartic shell middens improves interpretations relative to site function and intensity of frequentation. Further work on new samples from ethno-archaeological, experimental and modern analogue conditions is needed to corroborate and enhance these first results and insights into human dynamics in sub-polar conditions in both hemispheres.
At the same time, micromorphology and phytolith analysis allowed: (1) greater stratigraphical definition, (2) evaluation of the effects of taphonomic processes on the “transformation” of the final archaeological record, (3) recognition of specific spatial patterns inside the dwellings, and (4) definition of the actual function of anthropic features such as fireplaces.
Likewise, the study of lithic technology with the aim of unravelling the context of use of stone tools as well as the production-consumption processes in which these tools were involved provided insights into the dynamic of resource exploitation. Phytolith analysis from stone tools residues, even though it did not provide conclusive evidence concerning tools use has been useful as an exploratory analyses to improve the residue recovery procedure.
In all cases, the ethnoarchaeological enquiry has been used to formulate hypothesis that have been tested in an archaeological record generated *ad hoc* for answering the explicit research questions. Some research strategies, such as horizontal sampling for the recognition of spatial patterns or the digging method that gives the possibility to distinguish occupation events have been essential for the development of this research.

Acknowledgments

We would like to thank the following granting bodies for their support: The Wenner-Gren Foundation for Anthropological Research “Social aggregation: a Yamana Society’s short term episode to Analyse Social Interaction”; Ministry of Science and Innovation, Spain (HAR2009-06996); Consejo Nacional de Investigaciones Científicas y Técnicas de la República Argentina (PIP0706 and); Spanish National Research Council and Consejo Nacional de Investigaciones Científicas y Técnicas de la República Argentina (2005AR0099). The authors would like to thank all the people who have collaborated during the fieldwork seasons and specially to Assumpció Vila and Jordi Estévez for their helpful comments and remarks.

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Figure Captions

Figure 1. Map of Tierra del Fuego and archaeological sites analyzed on this paper.

Figure 2. Shell middens on the Beagle Channel coast (Río Encajonado, Tierra del Fuego, Argentina).

Figure 3. (a) Position of column 11 within Tunel VII stratigraphy (b) Photograph of resin-impregnated column 11 indicating position of thin sections (c) Off-site soil profile (d) Microscopic images of weathered (left) and burned (right) whale bone (e) Microscopic view of experimentally burnt *Mytilus sp.* shells.

Figure 4. Sampled areas for phytolith analysis in Túnel VII site

Figure 5. Use-wear traces of bone cutting. Magnification:200x.

Figure 6. Residues samples taken in relation to lithic artifacts in Lanashuaia, fieldwork season in 2005.

Figure
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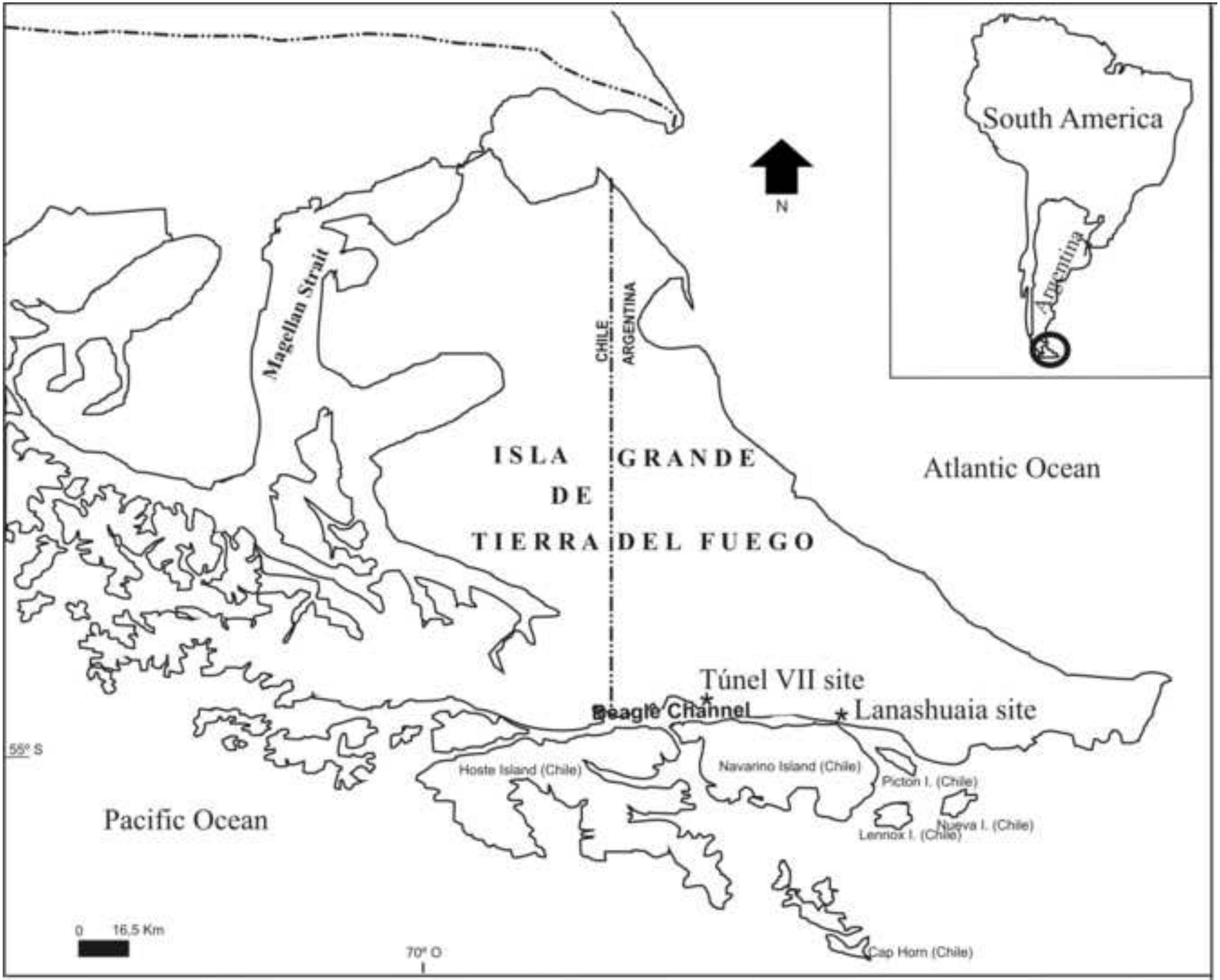

Figure

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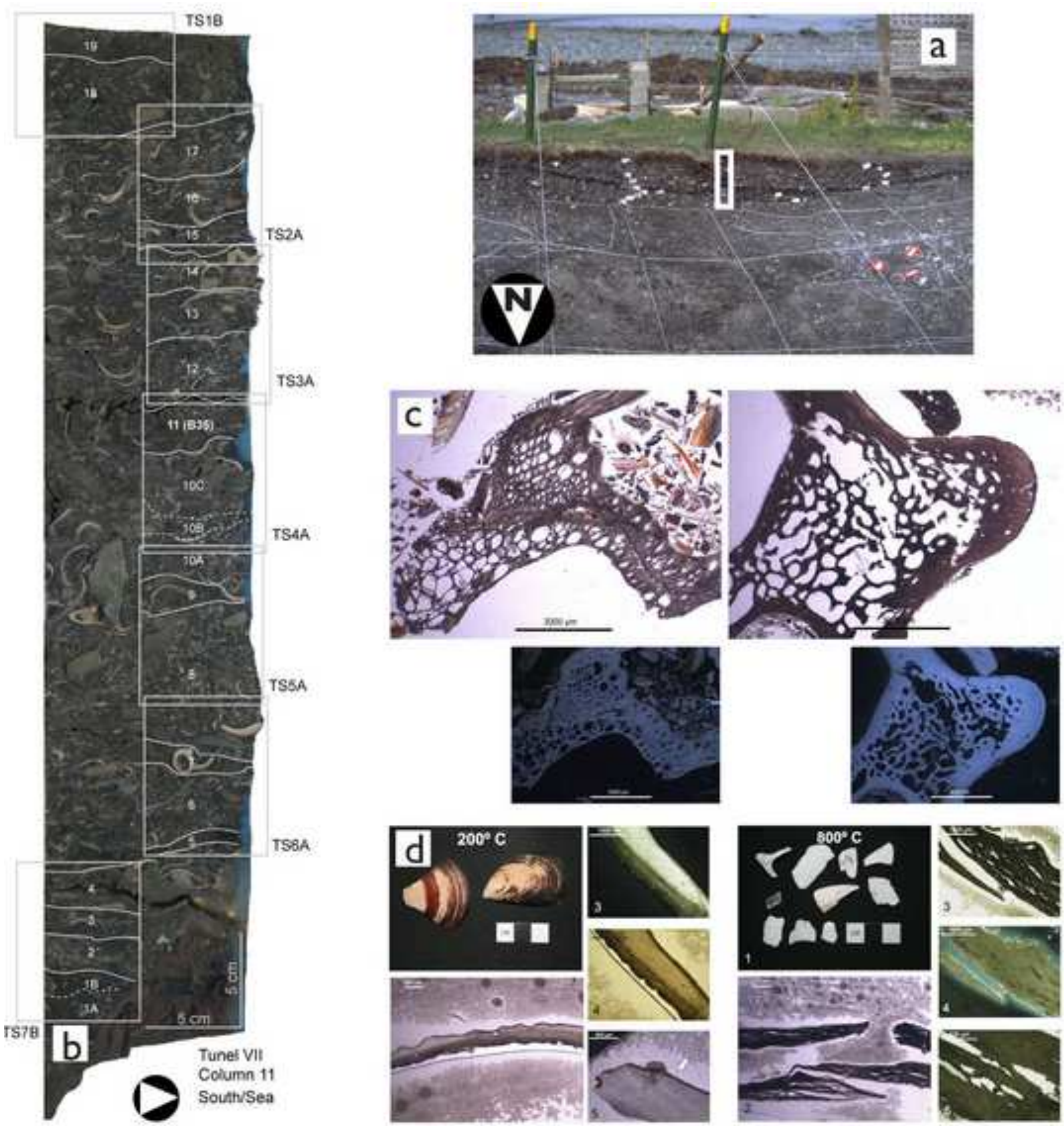

Figure 4
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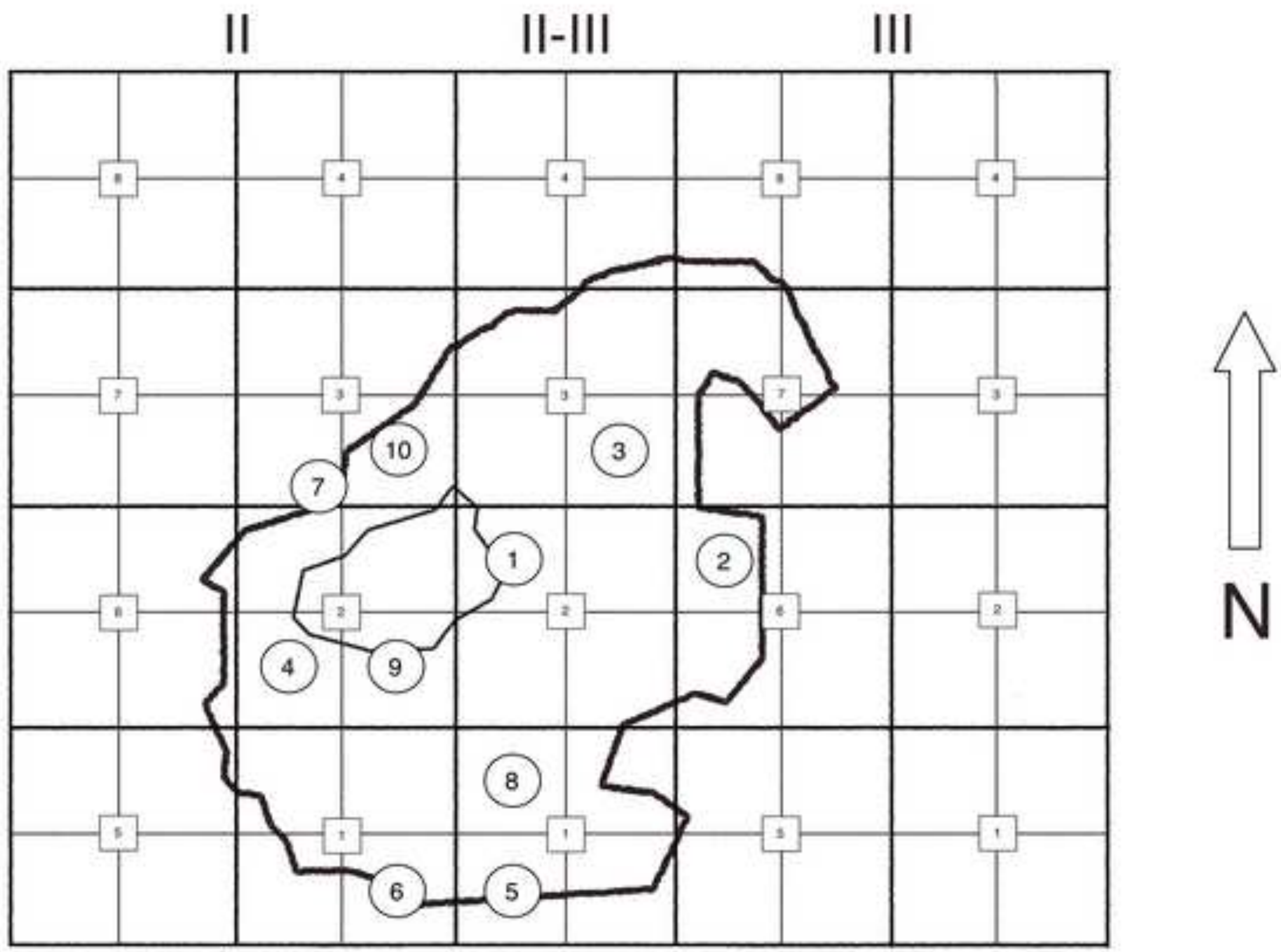

Figure 5
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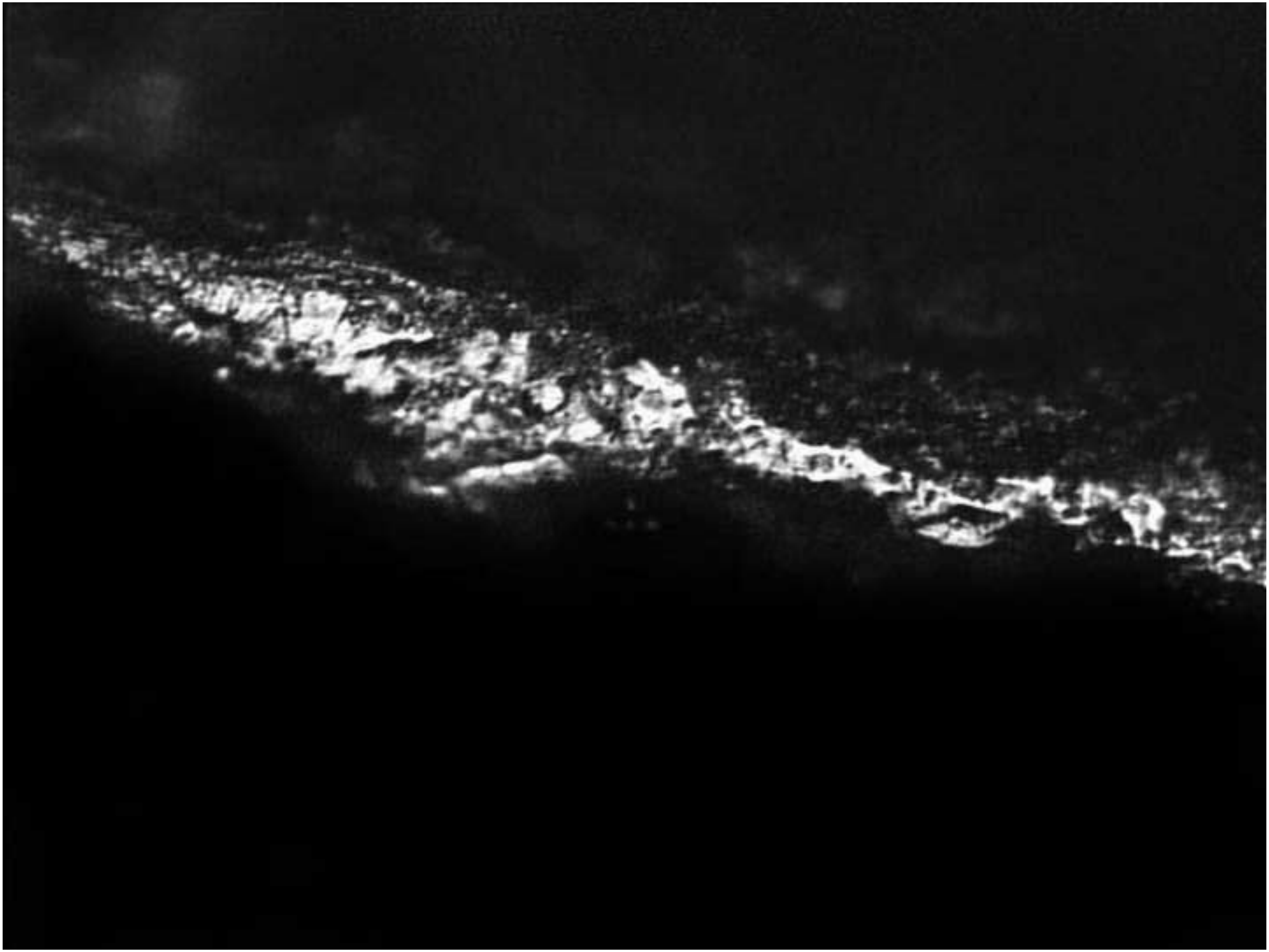

Figure 6
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